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Study of Constructing Asset Management System for Ground Anchor

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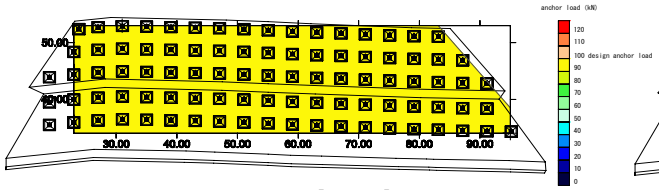
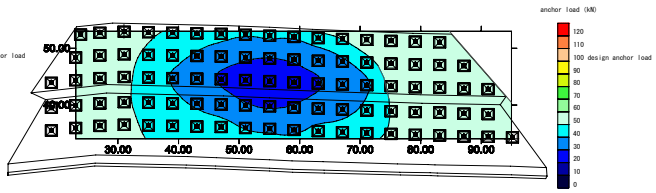
***ABSTRACT*:** We have developed a new investigation technology which is able to solve the most critical issue on constructing the asset management system of ground anchor. This technology will make a big progress in the maintenance of ground anchor, which is anticipated to become a problem near future. It is necessary to develop the database in order to construct the asset management system. However, there have been only a few progresses seen in the accumulation of the data on lift-up load, which is the most significant information of ground anchor, due to the problem in current investigating technology. Our technology with SAAM system has developed a new investigation method that enables us to measure the lift-up load of ground anchor efficiently. As a result of our research at anchored slope sites, we have obtained the distribution data of lift-up load on ground anchors, and consequently verified the efficiency of our technology and the necessity of revealing the actual conditions of anchored slopes. Being a major method for stabilizing slopes, ground anchor has been applied all over the world and became an important social capital that has close relationships to human life. It is important for human beings to develop a sustainable management system which contributes to the reduction of environmental loads as well as to the safety and security of our economic activities.

***KEYWORDS*:** ground anchor, asset management system, lift-up load

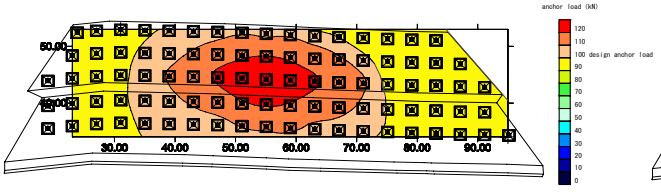
1. INTRODUCTION



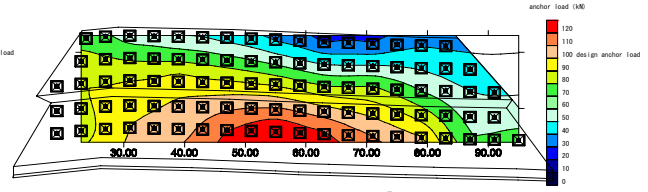
Pattern 1.Normal condition



Pattern 2. Recrease condition



Pattern 3.Increase condition



Pattern 4.Mixture condition

Figure 1.Disutribution pattern of anchor load

The maintenance of ground anchor has not sufficiently proceeded at many slope sites although there are a huge number of ground anchors. Therefore, there is not much information about the conditions of the anchor load, which is the most critical information regarding ground anchors.

It is considered that one of the reasons causing insufficient maintenance of the ground anchors is due to the size and weight of the hydraulic jack. Because the traditional type of the hydraulic jacks are huge and heavy, there have always been beset with costs and time issues for the preliminaries of the investigation; such as carry in and set up by cranes, scaffolding, and traffic control. (Picture 1)

Based on the hypothesis (Figure 1), we have developed a small and light hydraulic jack which enables us to investigate the ground anchors efficiently and effectively, and conducted a verification test.

Picture 1.The investigation by traditional type of the hydraulic jacks

This paper is reporting the outline of the research for constructing an asset management system of ground anchor as well as the method and result of the verification test using a new investigation technology.

2. SUMMARY OF THE RESEARCH

The objective of the anchor maintenance is to keep the safety and security of the slopes. We have been conducting a research to construct the asset management system. The system is able to evaluate the slope conditions quantitatively and objectively and properly manage them while using the ground anchors safely for a long time. (Figure 2)

For the construction of the system, it is necessary to develop the database and new technologies; such as, a method for estimating lifecycle cost, a method for predicting degradation of ground anchors and slopes, designing, constructing, maintenance technologies, and an advanced anchor method. In present, we have been collecting the data about anchored slopes and conducting a research about the investigation technology in order to build the database.

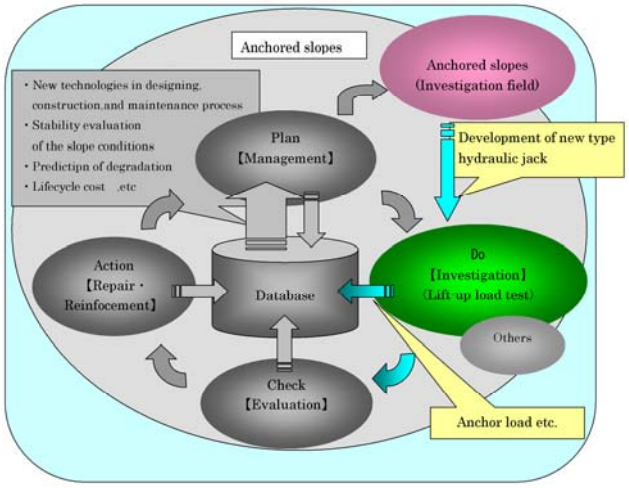


Figure 2.Summary of the research

3. BACKGROUND

In Japan, ground anchor method was adopted in 1950s. It has been more than fifty years since the old ones were constructed. Because mountains account for a larger part of the land, as the necessity for stabilizing cutting slopes due to the road maintenance has risen, the demand for ground anchor method has increased. In recent years, annually 2 thousand of ground anchors were constructed for the provision of stabilizing slopes and landslides. In last 8 years, 20 thousand ground anchor sites were executed. Suppose about 30 ground anchors were constructed in one site, it is estimated approximately 600 thousand ground anchors were constructed. (Figure 3)

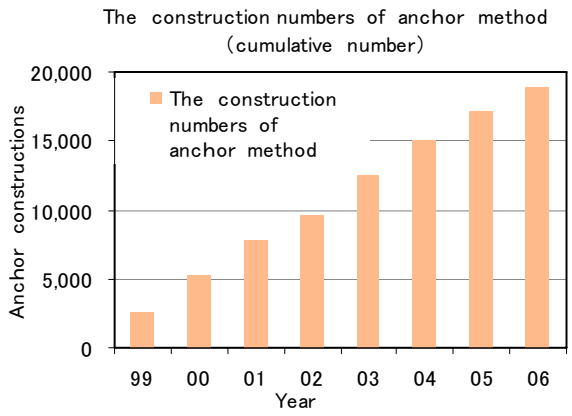


Figure 3. The number of anchor constructions (comulative number)

Before a new type of ground anchor was introduced in 1990, the ground anchor did not have sufficient corrosion prevention. Also, it did not have a function that enables to adjust the anchor load.

Today, it is confirmed that there are many cases regarding the degradation of the function in those old types of ground anchors. this is not only seen in the old type of anchor, but also in the new type of ground anchor, some of which have already been 15 years since constructed. (Picture 2)

Picture 2. Degradation in anchor

These are only the tips of the iceberg. Although it is not able to identify from the surface, the degradations could have been occurred in a huge number of ground anchors. Once it emerges, there is likely to be a great loss in social and economic activities. Therefore, it is necessary to make an effective provision before it happens.

4. THE CURRENT SITUATION IN THE MAINTENANCE OF GROUND ANCHORS

In the maintenance of ground anchor, visual inspection is taken for the standard method. Also, surface observation and load cell measurement are adopted as optional observation methods. Only when unusual conditions are observed by visual inspection and other observational methods, the anchor load is measured for a detailed inspection.

Because the structure of ground anchor is mostly buried underground, whether or not it is in effect is not able to be judged by visual inspections. When it is designed, there is a safety factor to check the conditions of ground anchor. However, there is only a safety confirmation by visual inspection when it is in the maintenance stage.

It has been observed by load cell (Picture 3) at important channels and Dam sites since ground anchors were constructed. However, there are several problems with the load cell measurements, it is necessary to examine the anchor load for which the construction has done in long time ago.

Picture 3. Load cell

5. DEVELOPMENT OF THE INVESTIGATION TECHNOLOGY

We have developed a new hydraulic jack which is able to measure the lift-up load of ground anchor efficiently and effectively. We have conducted the investigation applying this new hydraulic jack to the anchored slope sites.

5.1 Investigation of lift-up load on ground anchors applying a new hydraulic jack

Because this new type of hydraulic jack is designed small and light, it does not require cranes, scaffolding, and traffic control as it was needed when using the traditional hydraulic jacks. It requires only some simple equipment, such as a ladder. Therefore, it is easily able to conduct the investigation. Also it is able to conduct an additional investigation.

5.2 Investigation method for distribution of anchor load

The anchor load has a lot of information regarding effectiveness of anchor method and valuation of slope stabilities.

By investigating the distribution of anchor load, it is able to know the slope conditions. Since ground conditions differ in individual anchored slope site, it is able to acquire a lot of useful information for the maintenance of anchored slopes.

In general, an increase in the lift-up load shows a movement of the unstable soil block. On the contrary, a decrease suggests a subsidence of ground surface. Also, it is able to evaluate the effectiveness at the fixed point of ground anchor by putting a stress on it until the designed load.

6. RESULT OF THE INVESTIGATION

We have conducted a field investigation for the efficiency and adaptability of lift-up load test by applying a new type of hydraulic jack.

6.1 Lift-up load test

The following results come from one of the field investigation we have done do far.

We have conducted an investigation of lift-up load for 18 ground anchors in two days. (Picture 4) The operation was done by 4 people without heavy industrial machines and traffic control. A ladder is used for setting and removing equipments.

According to this investigation, it was confirmed that the work efficiency of lift-up load test was around 8 to 10 anchors per day. Generally, 4 to 5 anchors are the average work efficiencies when the traditional type of hydraulic jack is used. Also, it was confirmed that the lift-up load test was easily accomplished at the points where the traditional way of investigation would not have been easily executed.

Picture 4. The investigation by new type of the hydraulic jacks

6.2 Distribution of the lift-up load on anchored slopes

According to the investigation, there was hardly seen the slopes which have kept the original anchor load. In most cases, the lift-up load has changed in comparison with the original conditions.

Also, it was confirmed that the distribution of the lift-up load has changed in various ways. (Table 1, Figure 4)

Table 1 The outline of investigation sites

Site	Summary	Test/construction (numbers)	Constructed in
A	Keep original lift-up load	18 /18	2002
B	Decrease in the lift-up load	16 /16	2004
C	Excessive load on anchors	16 /16	1993-1994
D	Mixed in both under and over loaded anchors	62 /146	1991-1992

7 CONCLUSION

It is verified that the new investigation method applying a new hydraulic jack to lift-up load test enables to confirm the condition of anchored slopes efficiently. Also, the investigation developed the distribution of lift-up load on anchored slopes.

For the future, it is necessary to accumulate the data about lift-up load on ground anchor in order to construct the database as well as to consider the assessment method for stability of anchored slopes.

At the same time, we are going to conduct researches about the relationships between ground anchor and geology, and the mechanism of changes in the distribution of anchor load.

In the end, we would like to express a deep appreciation to all the people concerning with the investigation.

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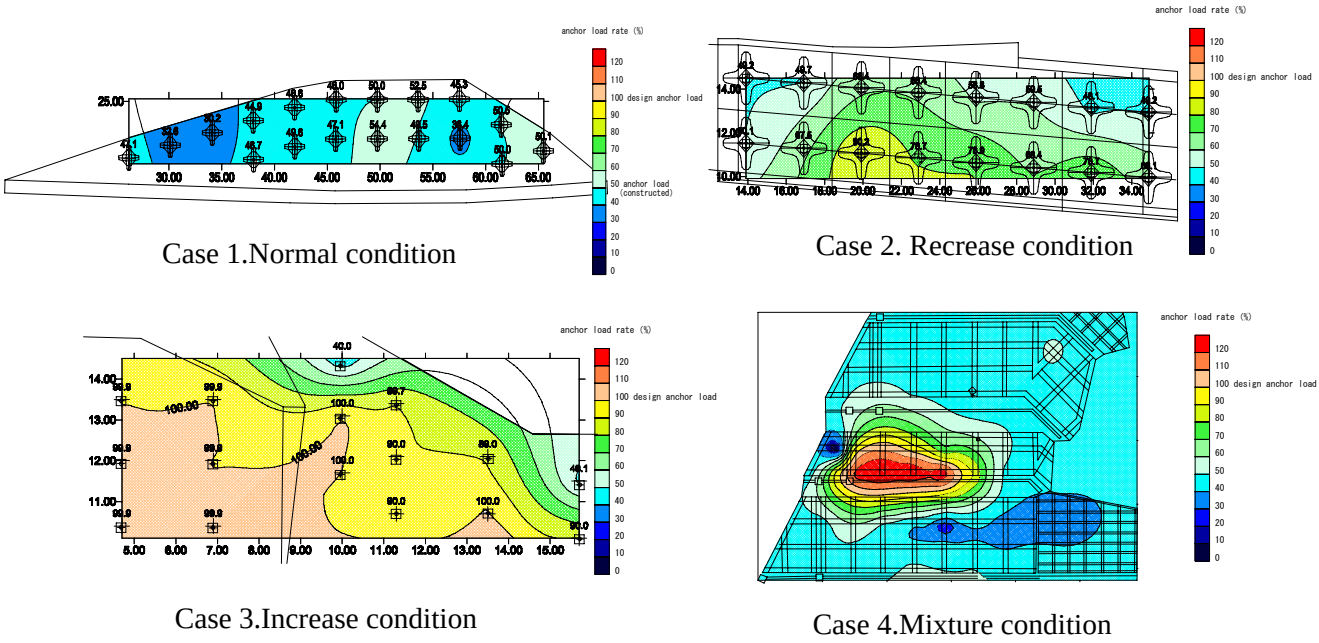

Case 1.Normal condition

Case 2. Recrease condition

Case 3.Increase condition

Case 4.Mixture condition

Figure 4. disutribution of anchor load